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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming	)	Docket No. 99-230
	)	
	)	
Federal-State Joint Board on Universal Service	)	Docket No. 96-45

Exparte Comments of the
Rural Utilities Service

Introduction

The Rural Utilities Service (RUS) is a rural development agency of the United States Department of Agriculture. For over 50 years, RUS (originally the Rural Electrification Administration) has been helping build modern telecommunications systems in rural America. Today, RUS continues to promote rural telecommunications by providing financing and technical advice to about 825 rural local exchange carriers.

This filing is intended to demonstrate that commonly-used statistics on the availability of cable TV and telephone service are not equivalent and, in particular, that cable TV is not as widely available as some statistics would seem to indicate. This issue is important because policy makers and regulators cannot make good decisions without accurate information.

Commonly Used Cable and Telephone Statistics Are Not Equivalent

Recently, RUS and the National Telecommunications and Information Administration (NTIA) released *Advanced Telecommunications in Rural America.*[1] That report is a response to a request by ten United States Senators for an analysis and comparison of broadband deployment in rural and non-rural areas.

1. *See* NTIA and RUS, *Advanced Telecommunications in Rural America: The Challenge of Bringing Broadband Service to All Americans*, rel. April 26, 2000 [hereinafter NTIA-RUS Broadband Paper]. A copy is attached to this filing. It is also available in PDF format at: www.usda.gov/rus/telephone/telephon.htm.

Among the issues raised by the Senators was the rate of deployment of broadband facilities in rural areas compared to non-rural areas. In our response, we focused on the two technologies with significant deployment numbers: broadband over cable television systems (cable modems) and broadband over telephone systems (digital subscriber line or DSL). A second issue of concern to the Senators was the capability of broadband enhancements to existing systems. Both issues require knowledge of the extent of existing facilities (*i.e.*, the area over which the service is "available" without significant construction) because these technologies are generally added to an existing cable TV or telephone system. While not all existing plant can carry broadband without modification, availability is a useful first step. In our research, we discovered that the commonly used statistics for the availability of telephone and cable TV are not equivalent, and when used as if they are, the result is a significant overstatement of the prospects for the availability of advanced services, particularly in rural areas.[2]

<u>Telephone Availability</u>

The U.S. Census collects information on telephone subscription, both in the decennial Census and through periodic estimates known as the *Current Population Survey*. The most commonly used statistic from the Census is service penetration - the ratio of households with telephone service to total households (a household in this case is an occupied housing unit). By this measure, telephone penetration on a national basis has held relatively steady at approximately 94% for the last several years of the surveys.[3] In addition to providing detailed and comprehensive information on subscription down to the Census block level,[4] the statistics from the decennial Census can be compared and correlated with other Census data in a multitude of ways such as by income, race, and population density.[5]

It is important to note that this commonly-used statistic is a measure of subscription, not availability. The Census does not collect information on whether non-subscribers live in an area where telephone service is available so they do not publish a statistic such as "homes passed by telephone plant," which could be compared directly to one of the commonly-used cable statistics described below.

If such a statistic of telephone availability were available, it can be estimated that it would be significantly higher than 94%. For example, while there are some extremely remote rural areas without available telephone service, we know of no metropolitan statistical areas (MSAs) without near-ubiquitous availability. Thus, it can be assumed that virtually all the households

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2. Also, the statistics do not reflect cases where, because carriers expect low subscription rates, the carriers are reluctant to deploy service in high poverty rural areas, even when the population density would appear to support such deployment.

3. *See* www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/Monitor/mrd99-6.pdf

4. A census block averages approximately 20 households.

5. The Rural Task Force in their White Paper Number Two, *The Rural Difference,* used Census data to demonstrate significant differences between rural and non-rural areas served by Local Exchange Carriers. The paper can be found at: www.wutc.wa.gov/rtf/rtfpub.nsf?open

without telephone service in MSAs are passed by telephone plant. With the acknowledgement that this misses some non-MSA households with available service, it can be estimated that at least 98% of all households are passed by telephone plant.[6]

Cable Availability

There are no similarly comprehensive statistics for cable TV service. The Census, for example, does not gather information on cable television. The commonly used statistics are collected through private surveys and self-reporting by cable providers. One of the most frequently quoted statistics is "homes passed by cable as a percentage of TV Households," a measure that appears to describe availability. The Commission has reported such industry-provided statistics in its *Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming* from which this excerpt is taken:[7]

> ***Cable's Capacity to Serve Television Households.*** The number of U.S. Homes with at least one television ("TV households") was reported as 98 million at the end of 1997 and June 1998.[8] At the end of 1998 and June 1999, the number of U.S. TV Households was reported as 99.4 million.[9] The number of homes passed by cable was 94.6 million at the end of 1997 and 95.6 million at the end of 1998, an increase of 1.1%.[10] By the end of June 1999, the number of homes passed by cable was 96.1 million.[11] The number of homes passed as a proportion of the number of TV households increased 0.1% from 96.5% in December 1997 to 96.6% in December 1998, remaining at 96.6% of TV households in the first half of 1999.[12]

Based on extensive field experience in rural America, RUS staffers found these availability numbers surprisingly high. We know that cable TV is less available in rural areas, particularly in the unquestionably rural areas (outside of town and not in a Metropolitan Statistical Areas) where there are approximately 10 million households according to the 1990 Census.[13] During

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6. Based on the 1990 Census, there were 91,690,462 households in the nation. Of these, 1,229,991 were non-MSA unserved households.

7. *See* Sixth Annual Report: *Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming*, FCC 99-418, rel. Jan. 14, 2000 at ¶19 [hereinafter Sixth Annual Report].

(Footnotes 8-12 are from the Sixth Annual Report.)

8. Nielson Media Research. Nielson Media Research estimates the number of television households annually, and industry practice is to use this figure throughout the television broadcast season, which begins in September and ends in August of the following calendar year. Thus the figure for TV households in June 1999 is the same as the figure for December 1998. In App. B, Tbl B-1, we report the number of television households as of year-end 1998 and June 1999. These figures are from Paul Kagan Associates, and we use these estimates of television households for consistency with the remainder of reported figures in this section.

9. Nielson Media Research.

10. *See* App. B, Tbl. B-1.

11. *Id.*

12. *Id.*

13. *See supra* note 1 at 4-5 (including footnotes 9-12) and 19 (footnote 63).

research for the NTIA-RUS Broadband Paper, we found the reason for the disparity. As we noted in the paper:[14]

> Statistics for the availability of cable vary according to whether a comparison is made to TV households, all households, or housing units. The most commonly used statistic is to compare homes passed by cable to TV households. According to estimates developed by Paul Kagan Associates, Inc., and reported in the National Cable Television Association's (NCTA's) *Cable Television Developments*, there were 99 million TV households, 66 million cable customers, and 95.6 million homes passed by cable service. *See* NCTA, 23 *Cable Television Developments* 1 (Summer 1999). Using these figures, the ratio of homes passed by cable to TV households was 96.6%. *Id.* The Warren Report, a second source reported by NCTA on its website, estimated that there were fewer homes (91 million) passed by cable in 1999 based on information collected from cable providers (ncta.cyberserv.com/qs/user_pages/Dev%28statedata%29.cfm). Comparing the Warren estimate of homes passed to the Kagan estimate for TV households yields a ratio of approximately 92%.
>
> Another way to measure the availability of cable is to compare homes passed by cable to all households, not only TV households. According to a December 8, 1999 report, there were approximately 101 million households (occupied housing units) and 112 million housing units (occupied or un-occupied) as of July 1998. *See* Census Bureau, *Estimates of Housing Units, Households, Households by Age of Householder, and Persons per Household: July 1, 1998* (www.census.gov/population/estimates/housing/sthuhh1.txt). Comparing the Kagan and Warren estimates for homes passed to total households yields ratios of 95% and 90%, respectively.
>
> Finally, a third comparison is between houses passed by cable and total housing units. This comparison is especially useful because there is evidence that cable providers may be reporting housing units passed, not households or TV households passed. For example, the Warren report listed 258,832 homes passed by cable in Washington, D.C., while Census estimated 265,000 housing units but only 225,000 households for the same area. The cable provider in Arlington, Virginia reported 89,968 homes passed and 89,968 housing units in its franchise area. It is reasonable that providers report housing units passed because, when it does not serve a house, a cable provider has no easy way to distinguish among a household without TV, a household with TV, or an unoccupied housing unit. Comparing the Kagan and Warren estimates for homes passed to total housing units yields ratios of 86% and 81%, respectively.

Since the publication of the NTIA-RUS Broadband Paper and in response to an RUS request for clarification (attachment A), the Warren Publishing Company has confirmed (attachment B) that the phrase "homes passed by cable" refers to housing units, not households or TV households. Put another way, using the Kagan estimates, cable may pass 96.6% <u>as many</u> housing units as there are TV households, but it does not pass 96.6% <u>of</u> TV households because some of the houses it passes are households without TV or are unoccupied. If cable TV were nearly universally available, (that is, available to nearly all of the of the 112 million habitable units

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14. *Id* at 19 (footnote 62).

whether or not those units have a TV or are currently occupied) the ratio of "homes passed by cable" to "TV households" would approach 113%, not 100%.[15] Of the estimated 14% to 19% of houses not passed by cable, most are TV households in rural areas.

Public Policy Implications of the Overstatement of Cable TV Availability

The incorrect perception of near-universal availability of cable TV is widespread[16] and has important public policy implications. First, it seems to undermine the need for universal service support for telephone service. If it could be argued that cable TV is available to 97% of households without support, it could also be argued that telephone service, which reaches only 94% of households, should not be supported. Second, it could lead to complacency about broadband deployment in rural areas. For example, in a recent paper, the authors quoted FCC-reported cable statistics[17] in support of their conclusion that there is no reason to believe that broadband will not be ubiquitously deployed over cable systems in the near future in rural areas.[18] If it is known that narrow-band telephone is available to at least 98% of the population whereas cable is available to an estimated 81% to 86% of the population, and most of the areas where it is unavailable are rural, then the need for preserving and advancing universal service and the challenges of rural broadband delivery are compellingly demonstrated.

Meeting the broadband challenge in rural America will likely require modernization and extension of both cable and telephone plant. Distance and density remain the major impediments to rural broadband. A combination of policies including universal service support, competition, affordable access to capital, new technologies, and regulatory incentives will all be necessary to achieve the vision of the Telecommunications Act of 1996.

Conclusion

Commonly used statistics for the availability of cable TV and telephone service are not equivalent. Caution should be exercised in using such statistics to draw conclusions about the pressing telecommunications needs in rural America. Broadband provided over cable TV

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15. 112 million housing units (Census estimate) ÷ 99 million TV households (Kagen report of Nielson estimate) = 113%.

16. For example, in a comparison of satellite and cable TV services, a leading consumer testing organization reported that "[a]lmost all households now have access to cable, but satellite service is still limited to those people whose home affords a clear view of the sky above the southern horizon." *See Satellite TV comes down to earth,* Consumer Reports, July 2000, at 19 and 20. Not only is this perception of near universal availability untrue, it was this lack of availability of cable TV in rural America that was largely responsible for the unexpectedly rapid initial growth in the number of customers served by satellite.

17. In the Sixth Annual Report, the cable statistics are presented in such a manner as to suggest that the ratio of "homes passed by cable" to "TV households" is a genuine measure of cable availability when it is actually a much less meaningful comparison of incompletely overlapping sets, *i.e.*, there are units in the numerator that are not in the denominator. Both the heading of the paragraph excerpted above (*Cable's Capacity to Serve Television Households.*) and the use of the word "proportion" in the phrase "the number of homes passed by cable as a proportion of the number of TV households" imply that every "home passed by cable" is a "TV household."

18. Lee L. Selwyn *et al*, *Bringing Broadband to Rural America: Investment and Innovation in the Wake of the Telecom Act,* September 1999 at 22 and 29.

systems is growing rapidly and the competition between cable modems and DSL provides those in more densely populated areas a choice. However, cable TV does not reach an estimated 14% to 19% of American houses and most of those houses are in rural areas. Thus, comparing the number of "homes passed by cable" to "TV households" creates the misleading perception that cable TV is available almost everywhere and that it is just a matter of time until rural cable systems can provide broadband. This perception could reduce efforts to promote rural deployment and rural development of broadband capable plant.

The RUS appreciates the opportunity to comment.

JUN 22 2000

Christopher A. McLean
Acting Administrator
Rural Utilities Service

Date

USDA

United States Department of Agriculture
Rural Development

Rural Business–Cooperative Service • Rural Housing Service • Rural Utilities Service
Washington, DC 20250

COPY

April 18, 2000

Mr. Michael Taliaferro
Managing Editor and Assistant Publisher
Warren Publishing, Inc.
2115 Ward Court, NW
Washington, DC 20037

Dear Mr. Taliaferro:

This letter concerns two of the television statistics published annually in Warren's Television & Cable Factbook (Factbook). Recently, my associate, John Huslig, discussed this in a telephone conversation with Richard Koch, the assistant managing editor and editorial director of your organization. Specifically, the Rural Utilities Service is interested in the definition of "homes" in the statistics "homes passed by cable television facilities" and "homes in franchised area."

On page D-10 of the 1999 Factbook, "homes in franchised area" is defined as the number of "housing units" in the area for which the cable system holds the franchise. (According to the Census definition, housing units include all habitable structures, occupied or not.) In their conversation, Mr. Koch told Mr. Huslig that the same definition applies to "homes passed by cable." In other words, the definition of "homes" in both statistics refers to housing units as defined by the Census, not households, which are occupied housing units.

RUS would appreciate your confirming that the "homes passed" statistic is the number of housing units passed by cable, as reported to your organization by the individual cable systems. Please call Mr. Huslig at 202-720-0665 if you have any questions in regard to this request.

Sincerely,

GARY B. ALLAN

GARY B. ALLAN
Chief, Universal Services Branch
Advanced Services Division
Rural Utilities Service

Attachment A

WARREN ... S NEWS 2115 Ward Court, N.W. Washington, D.C. 20037 202-872-9200 Fax: 202-293-3435 www.warren-news.com

April 24, 2000

Mr. Gary B. Allan
Chief, Universal Services Branch
Advanced Services Division
Rural Utilities Service
U.S. Department of Agriculture
Washington, DC 20250

Dear. Mr. Allan,

I received your letter of April 18th regarding Warren's definitions of "homes passed by cable" and "homes in franchised area" as presented on page D-10 of the 2000 Television & Cable Factbook.

In both cases, the term "homes" means the number of housing units. As you pointed out, the wording is a bit confusing and therefore will be changed in the 2001 edition to read "housing units".

Thank you for bringing this to my attention.

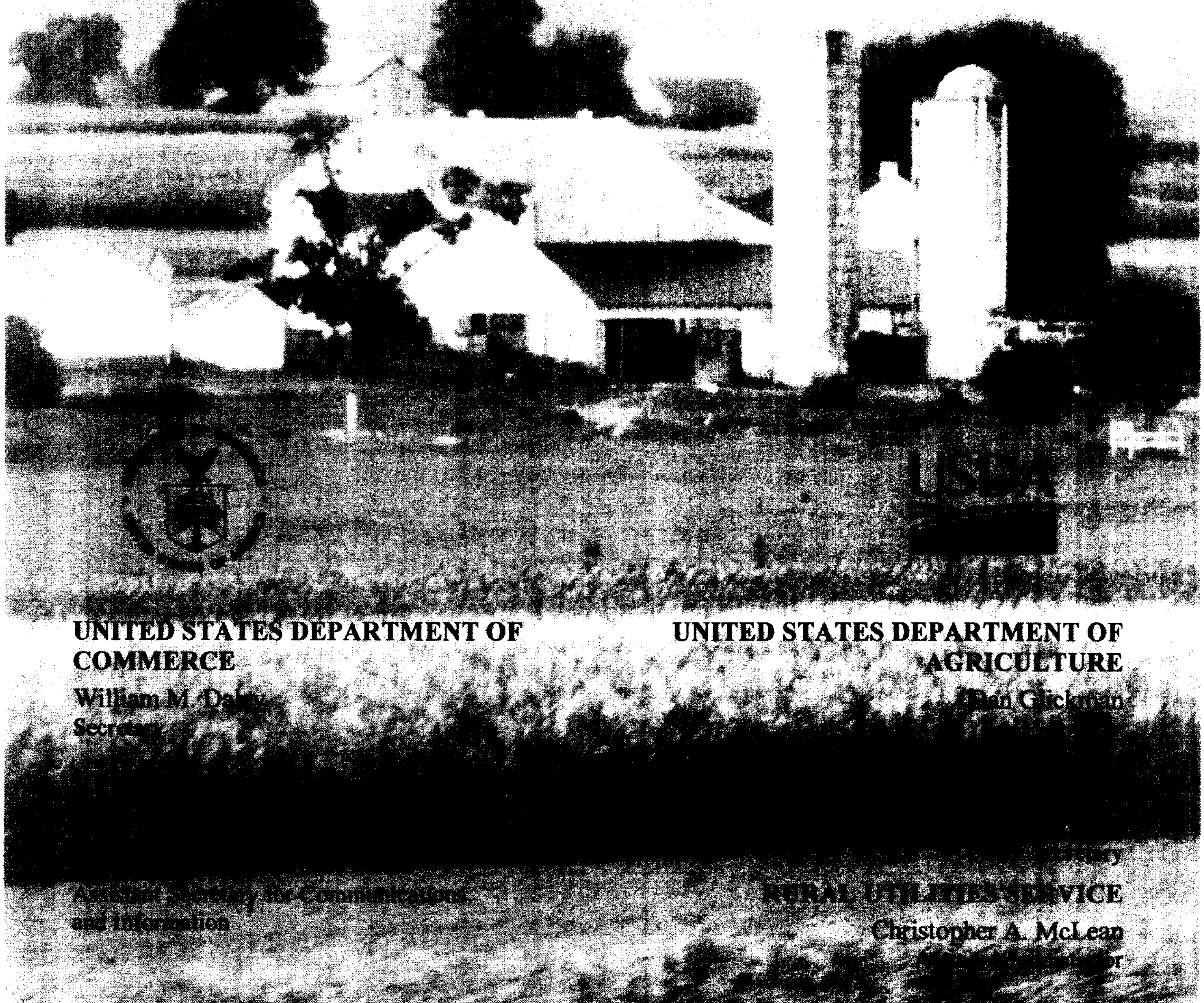
Sincerely,

Michael Taliaferro
Managing Editor, Television & Cable Factbook

Attachment B

ADVANCED TELECOMMUNICATIONS IN RURAL AMERICA

The Challenge of Bringing Broadband Service to All Americans



UNITED STATES DEPARTMENT OF COMMERCE
William M. Daley
Secretary

Assistant Secretary for Communications and Information

UNITED STATES DEPARTMENT OF AGRICULTURE
Dan Glickman

RURAL UTILITIES SERVICE
Christopher A. McLean

Advanced Telecommunications in Rural America

The Challenge of Bringing Broadband Service to All Americans

National Telecommunications and Information Administration

Gregory L. Rohde, Assistant Secretary for Communications and Information

Rural Utilities Service

Christopher A. McLean, Acting Administrator

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Kenneth C. Allen, Electronics Engineer
John J. Lemmon, Physicist
Frank Sanders, Electronics Engineer
Perry F. Wilson, Electronics Engineer

for RUS

Office of the Administrator

Anthony Haynes, Confidential Advisor to the Administrator

Advanced Services Division

Orren E. Cameron III P.E., Director

Universal Services Branch

Gary B. Allan, Chief
John L. Huslig, Financial Analyst

2nd Printing, June 2000

EXECUTIVE SUMMARY

Advanced Telecommunications in Rural America is a response by the National Telecommunications and Information Administration (NTIA) and the Rural Utilities Service (RUS) to a request by ten U.S. Senators on the status of broadband deployment in rural versus non-rural areas in the United States. This report also responds to a call by President Clinton and Vice President Gore to bridge the digital divide and create digital opportunities for more Americans. The rate of deployment of broadband services will be key to the future economic growth of every region, particularly in rural areas that can benefit from high-speed connections to urban and world markets.

This report finds that rural areas are currently lagging far behind urban areas in broadband availability. Deployment in rural towns (populations of fewer than 2,500) is more likely to occur than in remote areas outside of towns. These latter areas present a special challenge for broadband deployment.

Only two technologies, cable modem and digital subscriber line (DSL), are being deployed at a high rate, but the deployment is occurring primarily in urban markets. Broadband over cable, which provides most broadband service, has been deployed in large cities, suburban areas, and towns. One survey found that, while less than five percent of towns of 10,000 or less have cable modem service, more than 65 percent of all cities with populations over 250,000 have such service.

DSL technology also has been deployed primarily in urban areas. The Regional Bell Operating Companies (RBOCs) are providing DSL service primarily in cities with populations above 25,000 according to public RBOC data. While more than 56 percent of all cities with populations exceeding 100,000 had DSL available, less than five percent of cities with populations less than 10,000 had such service. Deployment of both cable modems and DSL service in remote rural areas is far lower.

The primary reason for the slower deployment rate in rural areas is economic. For wireline construction, the cost to serve a customer increases the greater the distance among customers. Broadband service over cable and DSL is also limited by technical problems incurred with distance and service to a smaller number of customers. Both technologies, however, promise to serve certain portions of rural areas. Cable operators promise to serve smaller rural towns, and smaller, independent telecommunications companies and competitive providers may soon be able to offer DSL to remote rural customers on a broader scale.

Advanced services in rural areas are likely also to be provided through new technologies, which are still in the early stages of deployment or are in a testing and trial phase. Satellite broadband service has particular potential for rural areas as the geographic location of the customer has virtually no effect on the cost of providing service. Several broadband satellite services are planned. Their actual deployment remains uncertain, especially in light of the recent entry into Chapter 11 bankruptcy of two satellite service companies.

Wireless broadband services are also planned for rural areas. More immediately, multipoint-multichannel distribution system (and potentially local-multipoint distribution system) fixed service capabilities may provide a solution for some rural areas. In as little as five years, third generation mobile wireless services providing data rates as high as two megabits/second may be operational.

Policymakers should promote competition, where possible. Using the pro-competitive provisions of the Telecommunications Act, some competitive local exchange carriers have deployed advanced services in rural areas of the country. Some wireless carriers have also indicated an interest in providing voice and high rate data, especially if universal service policies can be reformed.

Competition leads to lower prices, more customer choice, rapid technological advances, and faster deployment of new services. Given unique challenges faced by rural Americans, however, other government policies must be considered as well.

In order to support advanced services in rural areas, NTIA and RUS recommend a number of actions. We recommend the continued support and expansion of those government programs, such as the E-rate program, that ensure access to new technologies including broadband services. We also urge the Federal Communications Commission to consider a definition of universal service and new funding mechanisms to ensure that residents in rural areas have access to telecommunications and information services comparable to those available to residents of urban areas.

Support for alternative technologies will also be crucial to the deployment of advanced services in rural America. The Administration is committed to increasing investment in research and development to promote the next generation of broadband technologies. NTIA and RUS will also collect and disseminate "promising practices" that can promote private sector investment in rural broadband services.

Table of Contents

I. INTRODUCTION

This is a joint report of the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce and the Rural Utilities Service (RUS) of the U.S. Department of Agriculture. This report responds to a letter to Mr. Larry Irving, former Administrator of NTIA, and Mr. Wally Beyer, former Administrator of RUS, co-signed by Senators Baucus, Conrad, Daschle, Dorgan, Harkin, Johnson, Kerrey, Murray, Wellstone, and Wyden (See attached letter). In their letter, the Senators requested that NTIA and RUS examine six issues relating to the availability and deployment of advanced telecommunication capabilities to all Americans, particularly those who live in rural areas.[1] These issues concern:

1. The investment in telecommunications facilities with advanced capability in rural areas compared with non-rural areas, including an assessment of the various levels of capability being deployed under different technologies and the bandwidth capabilities of such deployment and whether or not comparable bandwidth is being deployed consistent with the objectives under Section 254(b)(2) and (3) of the Communications Act and Section 706 of the Telecommunications Act.

2. The availability of telecommunications backbone networks and "last mile" facilities with advanced capability in rural areas compared with advanced telecommunications backbone networks and last mile facilities in non-rural areas.

3. The rate of deployment of advanced telecommunications capability in rural areas compared with the deployment of such capabilities in non-rural areas and identity of specific geographic areas where advanced telecommunications capabilities are being deployed at a significantly lower rate than the deployment of such services elsewhere in the Nation.

4. The feasibility of various technological alternatives to provide last mile advanced telecommunications capability in rural areas.

5. The capability of various technical enhancements to existing wireline and wireless networks to provide last mile advanced telecommunications capability in rural areas.

6. The effectiveness of competition and universal service support mechanisms to promote the deployment of advanced telecommunications capability and the availability of advanced telecommunications services in rural areas.

The Administration and the Congress have recognized the importance of deploying advanced capabilities to all people and regions in the United States. As Vice President Gore noted:

1. We have renumbered several of the issues in the Senators' May 20, 1999 letter to align them with the report's organization.

> One of the most important goals that President Clinton and I have set for this country is ... to make sure that every person in America, regardless of race, income, or where they live, will be able to participate in and benefit from the Information Revolution ....[2]

To ensure that all Americans can partake in the economic benefits of the digital economy, President Clinton convened an Electronic Working Group within the Administration. This past year, the Working Group fashioned three directives to guide its work over the next year, including a directive to close the digital divide between those with and without access to new technologies. President Clinton also announced new budget proposals to create digital opportunities for all Americans, as discussed in Part D, several of which will promote broadband deployment.

Advanced telecommunications capabilities are crucial to the future of an increasingly interconnected America. These advanced capabilities mean that data can be delivered at rates that far exceed what can be carried by an ordinary telephone voice circuit. What might have taken hours to deliver may now take minutes; what might have taken minutes, can take seconds. For example, a student with one megabit/second broadband access at home could conduct a one hour virtual tour of the Louvre in real-time from her own living room, while a child with a 28 kilobit/second modem would require 36 hours to download the same information.

Advanced capabilities are becoming ever more important as businesses and consumers increasingly rely on the Internet and on sophisticated applications incorporating audio and video which require sustained high information rates. Availability of advanced telecommunications will become essential to the development of business, industry, shopping, and trade, as well as distance learning, telemedicine, and telecommuting. The rate of deployment therefore has implications for the welfare of Americans and the economic development of our nation's communities.

This is particularly true for those who live in the rural towns and countryside, who can especially benefit from high-speed, distance-defying connections to external markets and employment opportunities, urban medical centers, large universities offering specialty courses, and similar distant resources. Access to broadband means, for example, that a rural automotive designer need no longer relocate to the company headquarters to participate in interactive, real-time computer aided modeling of a new vehicle. It also gives a doctor in rural America the kind of access to sophisticated, data-intensive applications (such as three-dimensional imaging) previously only available to doctors connected by a local area network.

Congress has repeatedly recognized the significance of improved telecommunications for rural America. In 1993, Congress enacted the Rural Electrification Loan Restructuring Act (RELRA).[3] A primary intent of RELRA was to spread the deployment of advanced services and to ensure that these services were deployed at uniform rates in rural and non-rural areas.

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2. U.S. Vice President Gore on Connecting Communities for the Future, Email for All Event, May 8, 1998 (www.iaginteractive.com/emfa/msg00029.html).

3. Rural Electrification Loan Restructuring Act, Pub. L. No. 103-129, 107 Stat. 1356, codified at 7 U.S.C. 902 *et seq.* *See* §935 (d)(3) regarding requirements for State Telecommunications Modernization Plans.

Congress more specifically addressed universal service in the Telecommunications Act of 1996,[4] which rests on the two pillars of competition and universal service. The universal service principles found in Section 254 of the Communications Act of 1934, as amended by the Telecommunications Act, are intended to ensure access to advanced services for all Americans, so that those living in rural areas will be able to share in the buildout of advanced services to the same degree as those living in more densely populated areas.[5] Section 706 of the Telecommunications Act complements the universal service provisions of Section 254 by directing Federal and State regulatory bodies to encourage the deployment of advanced telecommunications capability to all Americans.[6]

Advanced services are just beginning to be deployed on a broader basis, although they are still primarily available only for business and urban users. Most Americans with access to the Internet still connect through a telephone voice circuit.

This report is intended to provide an initial assessment of the availability and rate of deployment for rural and non-rural areas to help gauge whether all Americans are benefiting from advanced capabilities.

4. Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56 (1996), codified at 47 U.S.C. §151 *et seq.* [hereinafter Telecommunications Act].

5. Section 254(b)(2) provides that "(a)ccess to advanced telecommunications and information services should be provided in all regions of the Nation." Section 254(b)(3) provides that "(c)onsumers in all regions of the nation, including low-income consumers and those in rural, insular, and high cost areas, should have access to telecommunications and information services, including interexchange services and advanced telecommunications and information services, that are reasonably comparable to those services provided in urban areas and that are available at rates that are reasonably comparable to rates charged for similar services in urban areas." Section 254(c)(1) states that "(u)niversal service is an evolving level of telecommunications services that the Commission shall establish periodically under this section, taking into account advances in telecommunications and information technologies and services." The FCC in its May 8, 1997 order on universal service (Report and Order, 12 FCC Rcd 8776 (rel. May 8, 1997)) [hereinafter May 8 Order], stated that it will convene a Federal-State Joint Board to review the definition of supported services on or before January 1, 2001. In a keynote address at a Senate conference (*Going the Extra Mile: Closing the Digital Divide in Rural America*, held October 27, 1999), Chairman William Kennard stated that the Joint Board will be convened well in advance of that date.

6. Telecommunications Act, *supra* note 4. Section 706(a) provides that "(t)he Commission and each State commission with regulatory jurisdiction over telecommunications services shall encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans (including, in particular, elementary and secondary schools and classrooms) by utilizing, in a manner consistent with the public interest, convenience, and necessity, price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment." Section 706(b) requires the Commission to conduct a periodic inquiry. "(I)n the inquiry, the Commission shall determine whether advanced telecommunications capability is being deployed to all Americans in a reasonable and timely fashion. If the Commission's determination is negative, it shall take immediate action to accelerate deployment of such capability by removing barriers to infrastructure investment and by promoting competition in the telecommunications market." Section 706(c)(1) states that "(t)he term 'advanced telecommunications capability' is defined without regard to any transmission media or technology, as high-speed, switched, broadband telecommunications capability that enables users to originate and receive high-quality voice, data, graphics, and video telecommunications using any technology."

II. APPROACH, METHOD, AND DEFINITIONS

A. Approach and Method

The report provides an overview of broadband technologies and the deployment of these technologies. As yet, there are no comprehensive, publicly available surveys or studies documenting broadband deployment across the nation.[7] NTIA and RUS staff therefore provided this overview by drawing on a variety of sources including electrical engineering texts, professional and trade journals, specialized studies, and discussions with rural communication providers, Regional Bell Operating Companies (RBOCs), cable TV providers, terrestrial and satellite wireless communication companies, and state regulators. These discussions were supplemented with an examination of industry supplied information pertaining to current and future deployment of broadband services, where available.

The agencies decided not to collect information through a formal survey. We note that, on March 30, 2000, the Commission adopted rules requiring a semi-annual, mandatory collection of data on the availability of broadband services.[8] Given this systematic collection of data in the future, the agencies felt it would be best to provide an informal overview report at this point.

B. Definitions

The following terms are used through the report.

Rural: The term *rural* can be interpreted many ways. Many assume that any area outside of a major metropolitan area is rural. This is clearly too broad a definition as it includes fairly large cities.

NTIA and RUS have adopted the Census Bureau's definition.[9] In our report, *rural* means towns of fewer than 2,500 inhabitants as well as areas outside of towns, including farmland, ranchland, and wilderness. Under this definition, there were approximately 22.3 million households living in rural areas (approximately 25% of the total United States population), according to the 1990 Census.[10]

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7. Broadband information collected by the FCC up to this time has come from voluntary surveys that have not provided comprehensive data.

8. *See In the Matter of Local Competition and Broadband Reporting*, Report and Order, CC Docket No. 99-301 (rel. March 30, 2000) [hereinafter Broadband Reporting Order]. Providers are required to complete and file the Local Competition and Broadband Reporting Form (FCC Form 477) no later than May 15, 2000 and semi-annually thereafter. *Id.* On February 18, 2000, the FCC also released a second Notice of Inquiry to determine whether advanced telecommunications capability is being deployed to all Americans in a reasonable and timely fashion. *In the Matter of Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996*, Notice of Inquiry, CC Docket No. 98-146 (rel. Feb. 18, 2000).

9. *See* U.S. Census Bureau, Urban and Rural Definitions and Data (www.census.gov/population/censusdata/ur-def.html.)

10. *The Rural Difference*, Rural Task Force White Paper 2, January 2000, at 60 (based on RUS analysis of the 1990 Census conducted with assistance from the Rural Policy Research Institute) [hereinafter *Rural Difference*].

The Census definition encompasses both traditionally small rural towns and outlying areas, as well as areas that are developing or urbanizing. Approximately 43% of the households classified by the Census as *rural* are in metropolitan statistical areas.[11] That is, this definition may include areas that are only temporarily rural, such as suburban developments with brand new utilities built relatively close to an urban or suburban area. These areas tend to be relatively affluent and their characteristics are more like the adjacent metropolitan area than what one ordinarily thinks of as rural. Rural statistics can be misleading if these variations are not considered.

The remaining 57% of rural households are outside of metropolitan statistical areas and are more likely to be in areas traditionally considered as rural. Of these, 23.5% live in towns with fewer than 2,500 people. The remaining 76.5% (or approximately 10 million households) live outside of towns in areas that are often more remote or sparsely settled.[12]

The suitability of various telecommunications technologies will depend on the characteristics of the rural area. For example, low population density is linked to a high cost-to-serve for any technology, especially for wireline technologies such as telephone or cable TV. This is because customers in close proximity, whether in small towns or big cities, can be served with less wire than a similar number of customers scattered through the countryside where the wire cost can be orders of magnitude greater.[13]

Given the impact of geography and the population distribution on cost, we will discuss a technology's suitability for different kinds of rural areas. We will pay special attention to the most rural areas, *i.e.*, those areas outside of towns and suburbs. Historically, these areas have been the most expensive to serve and, generally, are the last to receive a new (or any) type of telecommunications service. In many cases, before the introduction of the Rural Electrification Administration's (now RUS) Telephone Program in 1950, these areas received no service at all. These customers provide the greatest test for the universal service principles in Sections 254 and the complementary provisions of Section 706 of the Telecommunication Act, which seek to ensure access to advanced services for all Americans.

Advanced Services: The term *advanced (telecommunications) capability* found in the Senators' letter and the term *advanced services* found in Sections 254 and 706 are taken to be synonymous. Such services are generally understood to mean digital information transmission rates (bit rates) that are significantly higher than the nominal 56 kilobits/second which can be transmitted through an ordinary, high quality telephone voice circuit. *Broadband* is another term commonly used to describe high bit rates. In this report, *advanced capability*, *advanced services*, and *broadband* will be used interchangeably.

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11. *Id.*

12. *Id* at 61. Although not published in the White Paper, the RUS analysis performed during its preparation showed that there are approximately 9.6 million households in this unquestionably rural area; that is, outside of towns and not in a metropolitan statistical area. This represented approximately 11% of the nation's households in 1990.

13. For wireline construction, a large part of the cost is the installation, irrespective of the size of the cable. There is a high fixed cost associated with plowing a mile of cable whether that cable contains one pair of wires or 50. This is sometimes referred to as the "sheath cost" and typically runs about $10,000 to $15,000 per mile. In low population density areas where pair counts are low, this is a dominant construction cost and it rapidly drives the cost per customer higher as the distance between customers increases.

We have adopted the Federal Communication Commission's (FCC or Commission) definition of *broadband:* the capability of supporting at least 200 kilobits/second in the consumer's connection to the network ("last mile"), both from the provider to the consumer (downstream) and from the consumer to the provider (upstream).[14] Because most consumers use the Internet to receive data, broadband service offerings are generally asymmetrical (*i.e.*, the downstream link operates at a higher rate than the upstream link).[15]

The following table demonstrates how the FCC definition of broadband compares to information rates required for different types of well-known applications, such as telephone and video.[16] The uses of broadband are obviously much more extensive than the list provided below.

Application	Representative Rate kilobits/second
V34 Modem over Telephone Voice Circuit	33
Inter-office Digital Telephone Voice Circuit	64
Low-resolution Conference-Quality Video (compressed)	200
Compact Disc Audio	1,400
VCR Quality TV (compressed)	1,500
Broadcast Quality TV (compressed)	5,000
High Definition TV (compressed)	20,000

At a rate nearly four times faster than the best conventional modem access over a voice circuit, a rate of 200 kilobits/second can be considered advanced. That rate, however, will not support high data rate applications such as VCR quality video. Nor will VCR-equivalent video likely be achieved through compression. The bit rate requirements of the various digital video qualities shown in the table above are already obtained through compression (data reduction), which reduces the bit rate to a small fraction (on the order of 1/30th) of the uncompressed digital rate. Compression has greatly reduced the bandwidth required for video and other information and has, for example, made it possible to provide high definition television in the same six megahertz bandwidth required for conventional analog television signals. However, the ability to compress

14. *See* Broadband Reporting Order, *supra* note 8, at ¶ 22 (explaining that "'full broadband' is synonymous with the term "advanced telecommunications capability," *i.e.*, as having the capability of supporting, in both the downstream and upstream directions, a speed in excess of 200 Kbps in the last mile."); *see also Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996*, 14 FCC Rcd. 2398, 2406 ¶ 20 (1999) [hereinafter Section 706 Report]. NTIA and RUS believe that two-way capability is an essential element of broadband service because it enables an end-user to be a content originator or service provider.

15. There are also services that do not meet the FCC definition of broadband yet offer higher rates than conventional dial-up modems, at least in one direction. These include two-way services where the upstream rate is under 200 kilobits/second and one-way (unidirectional) services that use some other path, usually the telephone, for the upstream link. In order to provide a complete overview, this report will also discuss these high data rate services.

16. This chart was prepared by RUS and NTIA using publicly available information. Some devices, such as the compact disc, operate at fixed rates. Others, such as compressed video, operate at varying rates according to need. The representative rates shown here are intended to put the requirements of different applications in context.

information is not unlimited. For a given level of perceived video quality including fidelity to the original image, today's mechanisms are approaching the point of diminishing returns for reducing the bit rate requirement. Any improvements in compression technology will be marginal compared to the reductions made to date and will not negate the need for broadband access to the Internet and other sources of information.

Users may need even higher bit rates in the future as Internet throughput rates increase and demand for high quality video and other information-intensive applications rises. Such demand will accelerate with the increasing use of distance learning, electronic commerce, medical applications, and as yet unforeseen uses of the Internet.

III. RESPONSES TO THE SENATORS' REQUESTS FOR INFORMATION

In their letter to the Administrators of NTIA and RUS, the Senators requested specific information on the deployment of advanced telecommunications capabilities, particularly in rural areas. The issues are set forth below, with the agencies' responses following each issue. In certain cases, we have combined our responses to the issues because of the overlapping nature of the material.

A. Capability and Availability of Advanced Telecommunications Facilities

Issue 1. Investment in telecommunications facilities with advanced capability in rural areas compared with non-rural areas, including an assessment of the various levels of capability being deployed under different technologies and the bandwidth capabilities of such deployment and whether or not comparable bandwidth is being deployed consistent with the objectives under Section 254(b)(2) and (3) of the Communications Act and Section 706 of the Telecommunications Act.

Issue 2. Availability of telecommunications backbone networks and "last mile" facilities with advanced capability in rural areas compared with advanced telecommunications backbone networks and last mile facilities in non-rural areas.

Part A treats the issues of capability and general availability of backbone and last mile facilities. We first examine these issues in relation to "backbone" facilities, the main arteries of the nation's advanced telecommunications network, and then turn to "last mile" facilities, which connect users to the network. In discussing "last mile" technologies, we have further divided our discussion between those that are significantly deployed and those that are not. A comparison of deployment differences between rural and non-rural areas is set forth in Part B.

We note that complete and reliable investment information is difficult to obtain at present. Regulated providers do not itemize their broadband investments, and non-regulated providers do not readily disclose such competitively sensitive information. Even if the investment data were available, it is unlikely that it could be identified as urban or rural. Investment must mainly be inferred from deployment and availability for existing systems and from estimates for prospective systems.

1. Capability and Availability of Broadband Backbone

The majority of the nation's broadband backbone is composed of fiber optic cables, with satellite links connecting areas that are difficult to reach by landlines or underwater cable. Fiber provides an almost unlimited capacity for transporting data at high rates. With current wave division technology, it is possible for a single fiber to carry 400 gigabits/second which is equivalent to two million broadband signals (at 200 kilobits/second) or six million telephone calls (at 64 kilobits/second).

Investment in backbone is proceeding at a rapid pace spurred largely by market forces unleashed by the divestiture of the Bell System and the rapid increase in demand for data services. Companies such as AT&T, MCI/WorldCom, Sprint, Qwest, Level 3, ITXC, and Williams have rapidly been building data networks. There are currently more than 40 Internet backbone providers, and six new networks (estimated to cost $18 billion) will come into service in the next two years.[17]

Cable systems, electric utilities, and municipalities have also deployed backbone. Utilities had already installed 40,000 route miles of fiber optic cable by the end of 1997.[18] Montana Power, for example, has installed 10,000 miles of fiber.[19] Midcontinent Cable, a cable operator in the Great Plains states, has constructed a 530-mile fiber optic network that is expected to connect approximately 150,000 subscribers in North and South Dakota.[20]

While many believe that the continued buildout of the backbone is appropriate in light of growing bandwidth demand, others have speculated that there may be too much backbone capacity.[21] Many of the installed fibers still are not used and remain as "dark fibers." In addition, advancements such as wave division multiplexing are allowing a greater portion of the fiber's potential bandwidth to be used and, as a result, are multiplying the amount of information each fiber can carry.

Despite the rapid buildout of these data networks, there still is the issue of whether long-haul fiber optic backbones are connecting rural areas. In a report released by iAdvance, it was claimed that some states have little or no access to broadband hubs and the broadband backbone. The report dubbed these states the "disconnected dozen."[22] This report of a backbone and backbone hub shortage was characterized by the Competitive Broadband Coalition as "myth."[23]

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17. *Setting the Record Straight: The Fallacies and Realities of the Broadband Debate,* released by the Competitive Broadband Coalition, Oct. 25, 1999 (citing *Building a Better Backbone - And Business Plan,* Inter@ctive Week, 9/16/99) [hereinafter *Setting the Record Straight*].

18. Section 706 Report, *supra* note 14, at ¶40.

19. *See* www.in-tch.com/maps-fiber.htm.

20. Jim Barthold, *Miles of Fiber Optics Connect the Dakotas, Midcontinent, ADC team for Network of High-Speed Data and Telephone Services*, Cable World, Feb. 1, 1999.

21. Rachel King, *Too Much Long Distance*, Fortune, March 15, 1999 at 107.

22. Eric R. Olbeter and Matt Robison, *Breaking the Backbone: The Impact of Regulation on Internet Infrastructure Deployment,* July 27, 1999.

23. *See Setting the Record Straight, supra* note 17.

The latter position is probably closer to the truth. It is true that the dedicated Internet backbone primarily connects urban centers, but access to this dedicated backbone can be provided to users through other network facilities. Though they serve some of the most remote areas, RUS-financed carriers who provide Internet access have found that there are many means to gain indirect access to the backbone. For example, the backbone can be reached over leased facilities. The most prominent source of leased connection is through the nation's toll and local providers, but there are also connections available from private providers such as the utilities mentioned above. These facilities, while part of the telephone plant or even private facilities, provide connectivity to the Internet backbone and can be considered extensions of the backbone.

As a result, access to the backbone is generally not a significant problem for rural areas. The exceptions are in extremely isolated areas outside the contiguous 48 states, such as the many scattered and remote villages in Alaska or islands that lack fiber connection to the mainland. These remote areas will no doubt require fiber or additional satellite capacity to reach the backbone.

2. Capabilities and Availability of "Last Mile" Technologies with Significant Deployment

In general, it is the last mile, not the backbone, that presents the greatest challenge to bringing broadband to all Americans. There are a number of last mile facilities that connect the user to the network. Several of these (cable modems and digital subscriber line) are being deployed rapidly. Others (such as fiber to the home and terrestrial and satellite wireless) are in the early stages of deployment or are still being tested with the expectation of deployment in the next few years. A table that follows this report summarizes the state of development of last mile facilities.

Cable Modem

The majority of broadband service today is provided over cable modems although authorities differ on the exact numbers of both subscribers and customers passed by cable modem ready systems. According to Cable Datacom News, a leading industry source, there were 1.5 million cable modem subscribers in the U.S. and 560,000 in Canada at the end of February 2000. The same source reported that cable modem service was available to 43 million North American homes.[24] According to another source, cable modems were in 1.1 million American homes at the end of 1999, and systems that were cable modem ready at that time reportedly served about 27 million customers.[25] Whatever the exact number, it is evident that the number of working cable modems and cable modem ready systems is increasing rapidly. Estimates of future penetration show even more variation. One analyst projects that there will be 9.6 million cable modem customers in 2004.[26] As discussed later, most of this penetration has occurred in large towns and metropolitan areas.

24. *Cable Modem Customer Count Tops 2 Million*, Cable Datacom News, March 1, 2000 (www.cabledatacomnews.com).

25. Seth Schiesel, *Broadband; How Broadly? How Soon?: A Technology's Promised Arrival May Finally Be Here,* N.Y. Times, Jan. 17, 2000, at C1 (reporting results from the Yankee Group) [hereinafter Schiesel].

26. *DSL Gaining on Cable as the Big Pipe of Choice*, Washington Post, Feb. 10, 2000, at E10 (reporting analysis from the Yankee Group).

Traditional cable television networks were designed to provide analog television signals to subscribers via coaxial cables. Until recently, only television signals (typically about 70 channels in earlier systems and 120 channels in more recent and upgraded systems) were transported downstream to the customer through a coaxial cable network with a node and branch structure.

Because coaxial cable has a useful bandwidth of nearly one gigahertz for short distances, it is a natural candidate for providing broadband data services and access to the Internet. The first cable systems adapted for data were unidirectional using the telephone for the return link. More recent systems are designed for two-way communication. According to information supplied by the cable industry, approximately 90% of existing cable modem service is two-way.[27]

Upgrading a cable system for two-way broadband service requires substantial financial investment. It has been estimated that the cable industry will expend $21 billion to upgrade their systems to reach roughly one half of the homes passed in the United States and an additional $31 billion to upgrade their systems to reach all homes passed.[28]

Most systems built today are not engineered to provide broadband to all their customers. Current practice in the cable industry is to provide broadband from a node passing between 500 to 1000 homes (350 to 700 customers) with the expectation that only a fraction of customers will take the service.[29] In the event of more widespread subscription to broadband, companies will need to split the nodes, which will require additional investment, or devote additional channels to cable modem service. The latter option may be problematic in the near term because of the impending transition to digital television. During this period, spectrum may not be available because providers will be duplicating the analog channels in the digital format.

There is also a limit to how far broadband can be delivered from the node. To maintain the quality of the TV signals, the signal must be amplified at about 2,000 feet from the node and reamplified every 2,000 feet after that. Each amplifier adds noise and subtle distortions that have a small cumulative effect on the TV signal but which can severely impair the performance of cable modem operation.[30] As a result, when a cable provider adds cable modem service to its

27. Sixth Annual Report: *Annual Assessment of the Status of Competition in Markets for the Delivery of Video Programming*, FCC 99-418, rel. Jan. 14, 2000 at ¶58 [hereinafter Sixth Annual Report].

28. *Cable Access Debate*, Excite@Home (www.home.net/source).

29. One must be careful when comparing projections of the number of customers a system can serve. Some of these projections are based on older concepts about the nature of Internet traffic, which assume that high data rates are usually needed only for extremely small periods to download a file or to load a page. Implicit in this assumption is that the customer does not use the shared channel for the vast majority of time and that, during this "idle" time, others can use the channel. This is why usage is sometimes referred to as "bursty." This assumption, however, is becoming less and less valid. As web pages become more graphically intensive and with the increasing use of applications that require high, sustained rates, the number of customers who can share a data channel will decline.

30. Even though a cable modem system is carrying a digital signal, the amplifiers are analog and simply "repeat what they hear." These amplifiers balance for attenuation with frequency, amplify, and then retransmit the TV channels including any noise, or distortion that has joined the signal or been added by the amplifier itself. This cumulative distortion does not occur, by contrast, with digital repeaters. Digital transmission is effective at resisting noise and other distortions because the signal is deliberately encoded so as to be unambiguous. For illustration purposes, if a system operates with only "1" and "0, when it receives a "1" that has been distorted by the

cable system, it generally adds no more than eight amplifiers, resulting in a maximum range of 16,000 feet from the node. Because it is more reliable and requires less maintenance and adjustment, the preferred method is to operate without amplifiers, which limits the range to about 2,000 feet.[31]

Cable can theoretically provide downstream broadband at multi-megabit rates. Under the recently-adopted industry standard, users share a bitstream, typically 27 megabits/second downstream and up to ten megabits/second upstream, but these rates are almost never available to a single user.[32] Because the capacity is shared, the system can slow dramatically under heavy use. For example, if 540 users simultaneously attempted to watch streaming video, the shared data rate could be as low as 50 kilobits/second per user. To prevent wildly varying performance levels, many systems restrict the maximum bit rate available to a single user to a minor fraction (10%, or less) of the full channel capability in both directions. Media General in Fairfax County Virginia, for example, restricts its Road Runner service to 1.5 megabits/second downstream and 192 kilobits upstream.[33] This means it falls slightly below the FCC definition of broadband, as do many of today's service offerings whether provided by cable, DSL, or other methods.

In addition to these factors, performance via cable also varies depending on the overall quality of the cable system and the subscriber's equipment, as well as the performance of the Internet. These variables mean that it is nearly impossible to provide a single number that describes cable data throughput rates. According to the cable industry, an individual subscriber may experience access rates between 500 kilobits/second and 1.5 megabits/second depending on the network architecture and traffic load.[34]

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transmission channel to "0.9," it knows it must be "1" and can restore it to its original form. Every time it passes through an amplifier, the amplifier can regenerate an exact original. When passing through analog amplifiers, this regeneration does not occur. Eventually, the signal is so deteriorated that it is no longer unambiguous. To return to the illustration, if the "1" has deteriorated to "0.5," the regenerator cannot know whether the signal should be a "1" or a "0."

31. *AT&T Plans Distributed CMTS Architecture: Lightwire Roadmap Calls for Integration of DOCSIS CMTS Funtionality into Mini-Fiber Nodes*, Feb. 1, 2000. (www.cabledatacomnews. com/feb00/feb00-5.html).

32. CableLabs (Cable Television Laboratories, Inc.) issued the DOCSIS 1.1 standard (Data Over Cable Service Interface Specification) on April 22, 1999. This specification allows cable operators to provide guaranteed bandwidth to cable modem customers (http://www.cablelabs.com/PR/DOCSIS-042299.html).

33. Mike Musgrove, *Cable Modems: Is the Price Right?* interviewing Media General's Bob Mechelin, August 13, 1999 (www.washingtonpost.com/wp-srv/business/talk/transcripts/pegaro081399.htm).

34. *Overview of Cable Modem Technology and Services*, Cable Datacom News (www.cabledatacomnews.com). In one field test of recent cable modems, long-term average performance was under one megabit/second. Jim Louderback, *A New Age of Consumer Cable Modems* (reporting field test results for throughput of five new DOCSIS cable modems), ZDNet.com (www.zdnet.com/zdtv/cablemodem/reviews/story/0/7501/2382118.html) (viewed on 1/20/00).

Digital Subscriber Line (DSL)

Digital Subscriber Line (DSL) is the second most widely used broadband service, and its deployment is also growing quickly.[35] While there is a range of estimates for DSL deployment, that range is not as wide as that for cable modem deployment, discussed above. According to one source, there were 504,000 customers at the end of 1999.[36] This source predicts that this number will climb to 2.1 million by year-end, 2000.[37] Some project that broadband via DSL will surpass cable within a year or two.[38] Long-term estimates, which are much more speculative, range from 7 million DSL customers in 2004[39] to 9.6 million in 2003.[40]

The customer start-up cost is about the same for DSL as it is for cable modem, typically \$200 to \$300. There are numerous service offerings, some of which do not meet the full definition of broadband because the upstream link is lower than 200 kilobits/second. Many customers choose downstream services offered in the 250 to 600 kilobits/second range. Some real-world tests show lower rate DSL outperforming cable modems.[41] Although cable modem performance varies with the number of users, DSL broadband operates at a more fixed rate.[42]

In contrast to cable systems, which require extensive upgrades to provide data services, a substantial majority (over 70%, according to one source) of the copper loops in the existing telephone system can provide some form of DSL broadband merely with the addition of equipment at each end.[43] SBC Communications, Inc. (SBC), for example, has pledged to make DSL available to 80% of its subscribers within three years.[44]

Unfortunately, many of the loops on which DSL cannot operate are in rural areas. Telephone loops can be grouped into two categories: those that extend less than 18,000 feet (about 3 ½ miles) from their central switching office or carrier serving area and those that are longer. The

35. Whereas cable broadband is primarily a residential service, approximately 33% of DSL services are for business at this time. According to TeleChoice, there were 504,110 business and residential customers at the end of the fourth quarter of 1999. Of these, approximately 76.5% were provided by incumbent LECs, 22% by competitive LECs, and 1.5% by inter-exchange carriers. *See* www.xdsl.com [hereinafter Telechoice]. The incumbents primarily served residences (81% residential) whereas the competitive and interexchange carriers primarily serve businesses (77% and 65% respectively). *Id.*

36. *Id.*

37. *Id.*

38. George T. Hawley, *DSL: Broadband by Phone*, Scientific American, October, 1999 (www.sciam.com) [hereinafter Hawley].

39. *DSL Gaining on Cable as the Big Pipe of Choice*, Washington Post, Feb. 10, 2000, at E10 (reporting analysis from the Yankee Group).

40. *See* Telechoice, *supra* note 35.

41. *DSL Beats Cable Modem in Prime Time Internet Performance Duel - Based on Over 150,000 Performance measurements on the Networks of At Home and Pacific Bell*, Press Release, Keynote Systems, Inc., May 17. 1999.

42. *See* Schiesel, *supra* note 25.

43. *See* Hawley, *supra* note 38.

44. Sixth Annual Report, *supra* note 27, at ¶62.

shorter loops can generally support DSL-based advanced services.[45] Most customers in cities and towns, even very small towns, are served by plant that is inherently advanced services capable given the addition of DSL equipment because they are served by these short loops.

Longer loops (over 18,000 feet) generally are not DSL-capable because they must be "loaded" to maintain quality voice service.[46] Loaded plant is laced with inductors placed every mile or so along the cable to maintain good frequency response in the voice band. This comes at the price of blocking higher frequencies, including frequencies needed for DSL broadband. As a result, people served by long loops, generally those in outlying rural areas, may not have DSL-capable plant.

Loading has fallen out of favor with the development of distributed carrier systems in the 1980s and, more recently, DSL. Indeed, the FCC's Synthesis Cost Model (which designs modern, efficient telephone plant with no barriers to advanced services) does not use loading.[47] Under this design, referred to as a carrier serving area (CSA) design, no customer is beyond 18,000 feet from a central office or distributed carrier system. As explained below in Issue 5, much of the plant in rural areas is now built in this manner. If universal service support is used to build the modern, efficient plant envisioned by the FCC, inductive loading, which acts as a barrier to broadband, will eventually disappear in rural areas.

3. Capabilities and Availability of "Last Mile" Technologies without Significant Deployment

Fiber to Homes and Businesses

Fiber optic cable, typically used for backbone networks and the nation's long distance phone network, can also be used to connect homes and businesses. A fiber modem at the home or business (or nearby, for fiber to the curb) is used to convert light waves into electrical signals.

Among last mile technologies, fiber offers the largest bandwidth and could truly bring "the death of distance." The information carrying capacity of fiber is many millions of times that of

45. While not as wide band as coaxial cable, twisted pair has always been capable of carrying broadband. T-Carrier, developed in the 1960s, carries 1.544 megabits/second for 6000 feet before it is digitally regenerated. It is extremely robust because it was designed for long-distance voice service. Better electronics and less robust encoding allow for higher rates or longer distances. This broadband capability has been exploited in recent digital subscriber line (DSL) systems, which multiplex the digital signal over an ordinary analog voice signal. In other words, the DSL equipment pulls the upstream data off of the wire before the voice circuit discards it and adds the downstream data above the frequencies in the voice signal. DSL can carry 1.5 megabits/second to about 18,000 feet operating in this manner. Even higher rates can be carried for shorter distances. VDSL, for example, can carry rates of 53 megabits/second to 1,000 feet.

46. Although there are other forms of DSL that can reach beyond 18,000 feet by using repeaters, these repeaters do not allow for the telephone to remain on network power. One of the strong points of DSL from a public safety standpoint is that the telecommunications provider powers both ends of the voice circuit just as in plain old telephone service (POTS) so the telephone remains available for emergency use during power outages. When a repeater is inserted, voice service is dependent on less reliable forms of local power at the subscriber end, such as batteries. The subject of telephone reliability is discussed further in footnote 82.

47. *See infra* note 81.

copper-based facilities such as twisted pair or coaxial cable. The loss of signal with distance is so small compared to copper that a fiber can carry bit rates thousands of times higher than cable modems and DSL for distances of one hundred miles with no intervening electronics.

The down side is that fiber to the home is costly. For a typical home or business the cost for terminal equipment alone was about $1,500 in 1997.[48] While this price has since dropped, it still is not as low as the typical cost of about $500 or $600 per subscriber for adding cable modem or DSL broadband to a cable or telephone system.[49] Even without considering the cost of a plant rebuild, connecting the user to a fiber network is significantly more expensive than upgrading existing cable or telephone plant.

For these reasons, fiber deployment directly to homes and businesses has been minimal to date. Several examples, however, demonstrate that fiber deployment may be worth the additional cost:

- Clear Works plans to provide voice, video, and data to 2,700 new residences in Virginia, with 1,500 planned for a later date.
- BellSouth intends to offer video and data to 400 Atlanta residences via ATM technology and expects to provide service to an additional 200,000 residences in Atlanta and Florida later in the year.
- SBC has already deployed fiber-to-the-curb at more than 30,000 residences in Richardson, Texas, and plans to add 10,000 more links by the end of the year.[50]
- The Rural Telephone Company, an RUS borrower in Kansas, has built a fiber-to-the-home system that serves the rural towns of Hill City and Bogue.[51] Early versions of the technology used in this project were financed as a field experiment by RUS.

Whether fiber optic cable will be deployed to a large number of individuals in the future remains to be seen. It will largely be a function of whether bandwidth appetite grows to HDTV levels (20 megabits/second) or higher, thus moving beyond the practical capabilities of cable modems and DSL. Assuming there is greater deployment of fiber to the home, the costs of fiber and subscriber lightwave equipment will also fall, potentially spurring even further fiber deployment.

Multipoint Multichannel Distribution System

Multipoint multichannel distribution system (MMDS), commonly known as "wireless cable," is a wireless system for delivery of data via point-to-multipoint microwave radio signals. It

48. Bhumip Khashnabish, *Broadband to the Home (BTTH): Architectures, Access Models, and the Appetite for Bandwidth*, IEEE Network, Jan. 1, 1997.

49. *See* Schiesel, *supra* note 25.

50. Jason P. McKay, *Optical Illusion Disappears*, 4 tele.com 15 (1999) (www.teledotcom.com) (describing Clear Works, Bell South, and SBC).

51. www.ruraltelephone.com/history/pagesix/index.htm

operates below three gigahertz (GHz) at distances up to 35 miles under the best circumstances.[52] Given this range, MMDS could be an attractive "last mile" solution.

MMDS is descended from the older Multipoint Distribution Service (MDS), which was designed to transmit only television signals. MDS never became widely deployed, probably because the allotted spectrum only allowed for the broadcast of about 32 analog TV channels, compared to the 60 or 70 channels typically found on cable systems.

The FCC approved use of MMDS for two-way data service in September 1998, which greatly increased the interest in MMDS.[53] Several companies have tested MMDS data service, including Wireless One, CAI Wireless, American Telecasting and People's Choice TV. In these tests, downstream rates have been as high as 10 megabits/second and upstream rates have been as high as 128 kilobits/second (rates that are lower than the FCC's definition for broadband). MCI/WorldCom has launched tests in Baton Rouge, Louisiana; Memphis, Tennessee; and Jackson, Mississippi, with plans for a more significant test this summer in Boston.[54]

MMDS is already deployed in several areas. In Phoenix, for example, Sprint now serves over 10,000 customers, competing with the local cable operator and U.S. West.[55] Nucentrix Broadband Networks (in the Dallas metro area) plans to offer MMDS to small to medium sized businesses. It is currently deploying MMDS in two of its 58 markets (Sherman-Dennison, Texas and Austin, Texas) with the intent to offer service to 18 additional markets by the end of 2001.[56] Collectively, MCIWorldCom and Sprint have spent approximately $3 billion acquiring MMDS licenses in areas holding more than 50 million people, half of whom reportedly live in rural areas.[57] They have announced a plan to deploy MMDS to rural markets, although the term "rural" was not defined.[58]

Local Multipoint Distribution System

Local Multipoint Distribution Service (LMDS) is another fixed wireless technology capable of providing broadband service. LMDS was originally used for one-way wireless cable-like

52. There are many factors that can reduce the practical range, the primary one being the limitations resulting from a line-of-sight requirement given diffraction and the curvature of the earth. For example, over flat ground with no intervening obstructions like hills or buildings, to achieve a 25-mile range requires that both antennas be 75 feet above the ground. To keep the customer end to a more reasonable 33 feet height requires a 500-foot central tower. *See* David Urban, *Data Over MDS Cable Modems with Fixed 2 GHz Radio Link* (www.adc.com/Corp/BWG/MSD/cmodems.html).

53. *In the Matter of Amendment of Parts 21 and 74 to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licensees to Engage in Fixed Two-Way Transmissions*, 12 FCC Rcd 19112 (1998).

54. Peter Goodman, *MCI WorldCom Plans Wireless Test*, Washington Post, March 28, 2000 at E1 [hereinafter Goodman].

55. Sixth Annual Report, *supra* note 27, at ¶90.

56. www.nucentrix.com.

57. *See* Goodman, *supra* note 54.

58. *Ebbers Points to Rapid Digital Divide Crossing by MCI-Sprint*, Wireless Today, Jan. 13, 2000. (Bernard Ebbers promised that the two companies will serve rural markets through MMDS within a year of the proposed merger.)

service. The FCC auctioned LMDS spectrum for two-way broadband data service in 1997 and required that licensees build out the service within ten years of winning the license.[59] LMDS offers higher data rates than MMDS, but has a much shorter range, typically no more than three or four miles. The large amount of spectrum allocated, 1,300 megahertz near the 30 gigahertz range, has generated significant interest in LMDS by the telecommunications industry.[60] This capacity is enabling some LMDS operators to provide data rates greater than 150 megabits/second. Many small and some large companies are interested in using LMDS to provide integrated broadband data, voice, and video services.

LMDS is being tested or deployed by several companies. Currently, most deployment is for service to business customers in urban areas, in competition with existing and new wireline providers. (LMDS can be far less expensive to deploy than new wireline facilities, for which providers must obtain rights of way and often face expensive installation costs in congested urban areas.) Cellular Vision USA now offers LMDS service in the New York City area. World Wide Wireless also offers LMDS (and MMDS) service in the suburban areas surrounding San Francisco and San Diego. Highspeed.com is offering LMDS in mid-sized and large cities in the western United States, including Walla Walla, Washington; Bakersfield, California; Boise, Idaho; Denver, Colorado; and Honolulu, Hawaii.

Other companies are exploring deployment in areas that are partially rural. As discussed below, however, rural deployment of LMDS may be limited by several factors.

Broadband Data Satellite Systems

Satellite systems may offer another possibility for broadband service. One specialized system that has just come on line is Tachyon, which markets its services to Internet Service Providers (ISPs). Tachyon provides a two-way broadband satellite link to connect end users to their ISPs, carrying the end user's Internet traffic via satellite to the ISP gateway. The system promises to help ISPs reach customers in more remote rural areas. Tachyon offers service at varying data rates, from 200 kilobits/second to two megabits/second for the downstream rate and from 64 kilobits/second to 256 kilobits/second upstream. Deployment of this service began in March 2000.

The best known satellite system currently offering general Internet access to residences in North America is DirecPC, which offers downstream service at $200 for the start up charge and a $30 monthly fee. DirecPC reports that remote customers are assured a clear satellite signal so long as a clear line of sight to the southern sky is maintained. Installation kits are available at local retailers across the country.

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59. *Rulemaking to Amend Parts 1, 2, 21, and 25 of the Commission's Rules to Redesignate the 27.5 GHz Frequency Band, To Reallocate the 29.5-30.0 GHz Frequency Band, To Establish Rules and Policies For Local Multipoint Distrisbution Service and For Fixed Satellite Services, CC Docket 92-297, Second Report and Order, Order on Reconsideration, and Fifth Notice of Proposed Rulemaking,* 12 FCC Rcd 12545 (1997) (Second Report).

60. This bandwidth is equivalent to about 217 conventional broadcast television channels, compared to 32 for MMDS.

DirecPC is provided over a system originally designed to deliver television programming. Subsequently, this system was adapted to provide limited high-rate Internet access. Downstream rates are shared and can be as high as 400 kilobits/second, while the upstream link is via standard phone lines. As such, it does not meet the FCC's definition of broadband. DirecPC also restricts heavier users under a "fairness" policy to rates that are a small fraction of the 400 kilobit/second maximum. This restriction may make DirecPC less attractive as a high-speed data link than other broadband technologies.

Because DirecPC provides customers in the most remote rural areas with the same quality of service provided to those in urban areas, it provides a preview of the potential for satellite broadband to eliminate geography and location as a cost factor. Several new broadband satellite systems are expected to come online in the next few years (as discussed in Part C), all of which will provide significantly higher capacities than DirecPC.

Summary on Capability and Availability

The problem with regard to broadband access in rural areas lies primarily with last mile connections rather than access to the backbone network. DSL and cable modems are the most widely available last mile broadband technologies. As discussed below, however, their deployment in rural areas lags that in urban areas. New technologies hold promise for broadband access in rural areas but may be years away from widespread availability.

B. Rates of Deployment in Rural and Non-Rural Areas

Issue 3. Rate of deployment of advanced telecommunications capability in rural areas compared with the deployment of such capabilities in non-rural areas and identify specific geographic areas where advanced telecommunications capability is being deployed at a significantly lower rate than such services are being deployed elsewhere in the Nation.

In responding to Issue 3, we address broadband services that are already widely deployed so that we can compare rural and non-rural areas and examine specific locales that are not yet served by these technologies. For this reason, we have limited our discussion to cable modems and DSL.

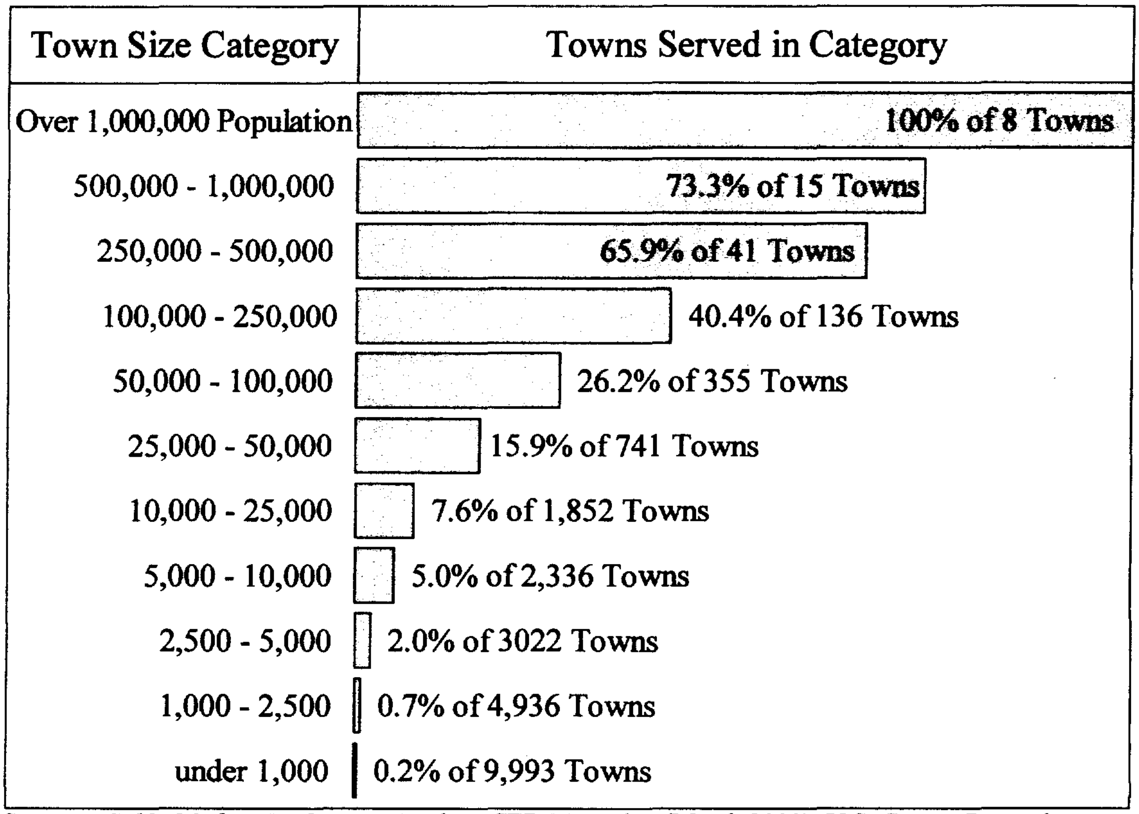
Deployment in urban and rural areas is not proceeding at a comparable pace. For various reasons, the major cable and DSL providers are both concentrating on serving metropolitan urban areas with high population densities. The likelihood of receiving broadband service through either technology declines with population density. As a result, residents in rural areas will generally be the last to receive service.

That said, the size of the provider and the nature of its service area are undoubtedly significant factors in determining which areas are served. Providers with both rural and non-rural service areas will likely bring broadband to their larger, urban, and more lucrative markets first, whereas rural providers are most likely to serve rural towns before remote, out-of-town areas. This means that those last served will be in the sparsely-settled countryside.

Cable Modems

In general, the larger the city or town, the more likely it is to find cable modem service. The information in Appendix A provides a recent snapshot of cable modem deployment, based on the "Cable Modem Deployment Update" in Communications, Engineering, and Design (CED) Magazine from March 2000. As noted previously, these numbers are changing rapidly.

Figure 1 - Broadband Cable Access by Town Size



Sources: *Cable Modem Deployment Update*, CED Magazine (March 2000); U.S. Census Bureau's *1990 Census Gazetteer.*

Figure 1 shows the deployment of cable modem service across cities and towns of various sizes.[61] This chart shows that the percentage of cities or towns with cable modem service declines as the population size decreases. For example, according to this study, cable modem service was available in some portion of all eight cities with populations exceeding one million. Cable broadband was also available in portions of more than 70 percent of cities with populations between 500,000 and one million. That rate declines for smaller cities. Approximately 25 percent of cities ranging from 50,000 to 100,000 in population had cable

61. This chart is based on Appendix A, which uses CED magazine's list of areas (primarily cities) with cable modem service in at least part of the city. We then used data from the U.S. Census Bureau's *1990 Census Gazetteer* (www.census.gov/cgi-bin/gazetteer) to determine the size of the cities. For the 26 counties identified in Appendix A, we identified cities and towns within those counties for which we could confirm cable modem service and included them in the chart.

modem deployment, compared to less than five percent of towns with populations between 5,000 and 10,000 and less than one percent in towns with populations under 2,500. We recognize that companies may report their deployment with varying degrees of accuracy and that any list is probably not complete.

For several reasons, cable modem service is less successful in reaching some rural areas. It is estimated that cable is available to somewhere between 81% and 97% of Americans, depending on the method of calculation.[62] Nevertheless, rural areas outside of towns still have less access to cable TV.[63] With the arrival of direct broadcast satellite for television, it is even less likely that cable systems will extend further into the countryside. Additionally, as with all types of wireline service, the costs of high-speed cable data deployment and operation in rural areas are high.[64] Because the subscriber base in rural areas is more dispersed than in more densely populated areas, there is less economic incentive to connect rural areas.

While the prospects for deploying cable modem service in remote areas outside of towns seems low, the prospects are higher in small rural towns. Appendix A shows that many small towns

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62. Statistics for the availability of cable vary according to whether a comparison is made to TV households, all households, or housing units. The most commonly used statistic is to compare homes passed by cable to TV households. According to estimates developed by Paul Kagan Associates, Inc., and reported in the National Cable Television Association's (NCTA's) *Cable Television Developments*, there were 99 million TV households, 66 million cable customers, and 95.6 million homes passed by cable service. *See* NCTA, 23 *Cable Television Developments* 1 (Summer 1999). Using these figures, the ratio of homes passed by cable to TV households was 96.6%. *Id.* The Warren Report, a second source reported by NCTA on its website, estimated that there were fewer homes (91 million) passed by cable in 1999 based on information collected from cable providers (ncta.cyberserv.com/qs/user_pages/Dev%28statedata%29.cfm). Comparing the Warren estimate of homes passed to the Kagan estimate for TV households yields a ratio of approximately 92%.

Another way to measure the availability of cable is to compare homes passed by cable to all households, not only TV households. According to a December 8, 1999 report, there were approximately 101 million households (occupied housing units) and 112 million housing units (occupied or unoccupied) as of July 1998. *See* Census Bureau, *Estimates of Housing Units, Households, Households by Age of Householder, and Persons per Household: July 1, 1998* (www.census.gov/population/estimates/housing/sthuhh1.txt). Comparing the Kagan and Warren estimates for homes passed to total households yields ratios of 95% and 90%, respectively.

Finally, a third comparison is between houses passed by cable and total housing units. This comparison is especially useful because there is evidence that cable providers may be reporting housing units passed, not households or TV households passed. For example, the Warren report listed 258,832 homes passed by cable in Washington, D.C., while Census estimated 265,000 housing units but only 225,000 households for the same area. The cable provider in Arlington, Virginia reported 89,968 homes passed and 89,968 housing units in its franchise area. It is reasonable that providers report housing units passed because, when it does not serve a house, a cable provider has no easy way to distinguish among a household without TV, a household with TV, or an unoccupied housing unit. Comparing the Kagan and Warren estimates for homes passed to total housing units yields ratios of 86% and 81%, respectively.

63. National Telecommunications and Information Administration, U.S. Department of Commerce, *Survey of Rural Information Infrastructure Technologies* (September 1995) at 3-7 ("Cable television service providers are generally unwilling to extend their cables into rural areas where the subscriber density is less than 10 per mile.")

64. National Cable Television Association, *Imposing Common Carrier-Style Regulations On Cable Would Impede Deployment of Cable's High Speed Internet Service to Rural and Small Communities* (May 1999) ("In lower density rural markets, where computer penetration is generally less than the national average, the high fixed costs involved in establishing high speed networks are spread over a much smaller customer base. Although customers are responding favorably, these small cable system operators are still unsure about how many customers they will attract and what return they will see.").

with populations less than 2,500 are already receiving cable modem service, including Freeman, South Dakota (pop. 1,293); Hardin, Kentucky (pop. 595); and Machias, Maine (pop. 1,773).

Many mid-sized and small cable operators are installing turnkey systems that allow them to offer cable modem service. For example, cable companies in conjunction with the ISP Channel are offering data services in such towns as Atchison, Kansas; Kennebunk, Maine; Lake Travis, Texas; and Bonneville, Mississippi.[65] While these towns do not fall under our definition of rural, they are certainly smaller than the large metropolitan areas where cable modem service first appeared.

In addition, a number of municipal utilities are offering high rate data services, primarily over cable systems. The American Pubic Power Association reported that, of the 127 municipal electric utilities across the country that currently offer telecommunications, approximately one-sixth are providing cable modem service.[66] Four of these systems are in the rural towns of Coon Rapids, Hawardan, and Manning, Iowa; and Schulenburg, Texas. Electric utilities are also providing service in somewhat larger towns, such as Scottsboro, Alabama; Fairborn, Georgia; and Barbourville, Kentucky.

To gauge the likelihood of deployment in rural areas, NTIA spoke to approximately two dozen small cable companies serving 1,000 customers or fewer about the deployment of broadband over their cable systems. Approximately half of the companies currently offer, or plan to offer, cable modem service to small towns, some of which would likely be rural. These companies reiterated that, because cable service is more economical where there is a higher density of customers, it is unlikely that they will build out to isolated customers in the rural countryside.

DSL

To date, DSL has been deployed primarily in urban centers. The Regional Bell Operating Companies (RBOCs) and GTE, which serve a large majority of all DSL customers,[67] planned to offer DSL to as many as 45 million lines (approximately 45% of their customers) by the end of 1999.[68] As demonstrated in Appendix B, RBOC DSL deployment has primarily occurred in cities of 10,000 or more, while most localities with DSL have populations of 25,000 or higher. These data are based on public information provided by the RBOCS (primarily on the Web) in

65. Lee L. Selwyn *et al*, *The Broadband Road to Rural America: The Competitive Keys to the Future of the Internet*, May 1999 at 72-3 and Table 3.3.

66. These municipal cable systems also provide Internet access, presumably over a cable modem system. *See* American Public Power Association, *Municipal Electric Utilities Providing Broadband Telecommunications Services* (1999). Other municipalities also reportedly offered "high speed data" service although it was not clear how this was delivered or at what rate and to whom it was delivered.

67. According to TeleChoice, 76.5% of DSL was provided by incumbent LECs *See* Telechoice, *supra* note 35. The RBOCs serve the vast majority of ILEC customers.

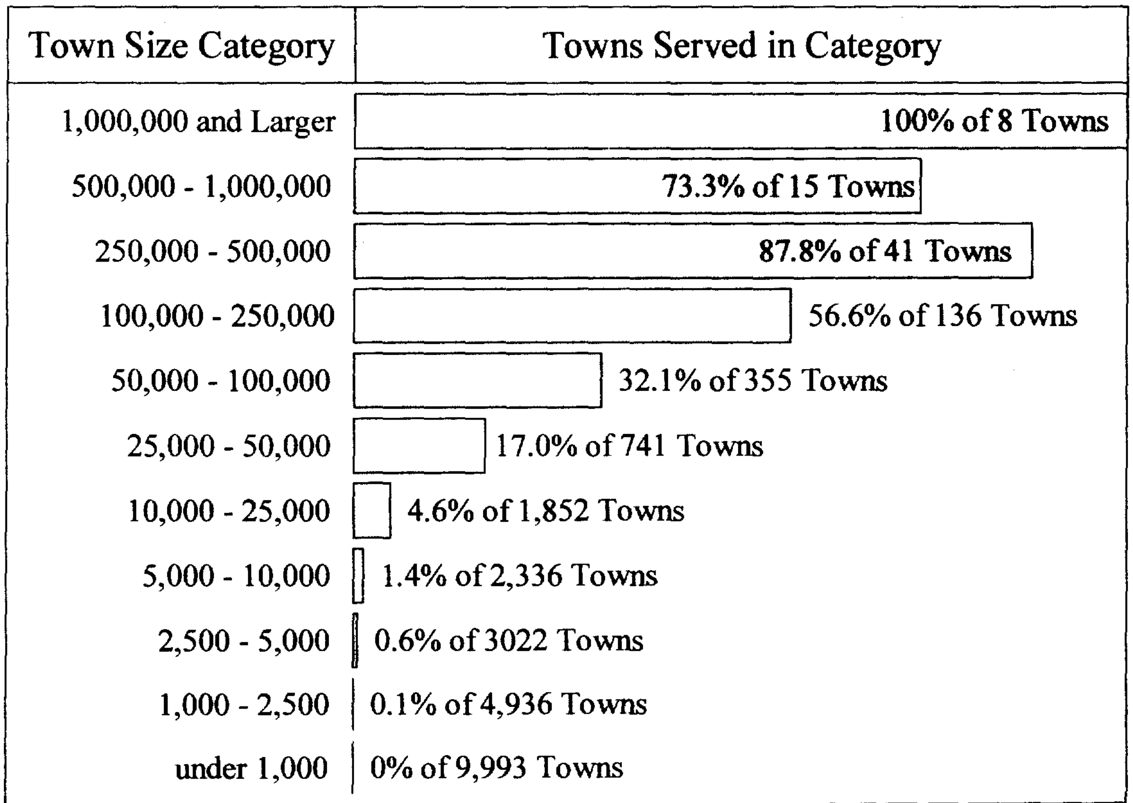
68. Selwyn, *et al., Bringing Broadband to Rural America: Investment and Innovation in the Wake of the Telecom Act,* September 1999, at 15. This figure may be somewhat ambitious because of extensive bridge taps in RBOC plant. However, bridge taps are easily remedied and do not represent a long-term roadblock to broadband like loading does for rural loops.

March 2000. The data provided by the various RBOCs differed in their degrees of comprehensiveness.[69]

According to the data in Appendix B, the major population centers on the West Coast are in the lead, followed by other metropolitan areas in the Western Interior, the Southeast, the Midwest, and the East Coast. With respect to small towns, DSL deployment has occurred more rapidly in more affluent small towns, such as Vail, Colorado, and Carmel, California.

Figure 2 shows the deployment of DSL service by the RBOCs across cities and towns of various sizes using data in Appendix B.[70] As reported in March 2000, the RBOCs were offering DSL service in portions of 551 cities or towns.

Figure 2 - RBOC Provided DSL by Town Size



Sources: Public Data From RBOCs; U.S. Census Bureau's *1990 Census Gazetteer.*

69. Some RBOCs, such as Ameritech, listed only a few cities in which they provide DSL. Others, such as Pacific Bell, provided a detailed, apparently more comprehensive, list.

70. This chart used data from Appendix B, and then used the Census Gazetteer to determine the size of the cities. This chart is not directly comparable to the chart on cable modem deployment, which was prepared using evidence from one source. The data from the various RBOCs, by contrast, vary in scope and detail, and do not include deployment by competitive and independent telecommunications providers. Additionally, the data may not be tied as closely to city boundaries as data provided for cable service. In certain instances, RBOCs may deploy DSL for the entire metropolitan service area, but only list the chief city's name. In these cases, Figure 2 may under-represent deployment in the surrounding urban area.

As can been seen in Figure 2, the percentage of cities with some RBOC-provided DSL service decreases rapidly with city size.[71] While all eight cities with populations exceeding one million had DSL available, only 1.4 percent of towns with populations less than 10,000 and 0.1 percent of towns with populations less than 2,500 had such service. (These figures do not include the many smaller cities where non-RBOC, smaller telephone companies may be deploying DSL.)[72]

Despite these figures, we cannot conclude that rural areas will necessarily be ignored for long. Competitive local exchange carriers (CLECs) provide approximately 22% of DSL nationwide.[73] Several of the CLECs intend to target less densely populated areas. For example, New Edge Networks, a wholesale data CLEC that typically operates in partnership with an Internet service provider, announced a two-year plan to provide DSL in smaller cities and what they describe as rural areas in all 50 states.[74] At the end of 1999, this CLEC was offering service in Sequim, Washington; Port Townsend, Washington; and other small towns throughout the Western States. Although these towns exceed our definition of rural, they are fairly small. Similarly, Northwest Telephone Inc. and Electric Lightwave Inc. agreed to offer high-speed services to businesses in Wenatchee, Washington, as well as to other communities in that state.[75]

Additionally, independent telecommunication companies have shown more interest in providing services to customers outside major population centers, and have demonstrated a greater willingness to build the plant necessary for advanced services. Those independent providers that are financed by the Rural Utilities Service are, in fact, required to upgrade their infrastructure so that it is DSL-capable when they build new plant or rebuild old plant. Under the Rural Electrification Loan Restructuring Act of 1993, all direct lending by RUS must be for plant that conforms to State Telecommunications Modernization Plans.[76] These plans require that financed plant, as built or with additional equipment, support the provision of data communications at a speed of one million bits per second.

In 1995, RUS began reviewing designs to ensure that financing went only for advanced services capable plant. Among other things, RUS looks for plant designs that ensure that customers are grouped so that loops do not exceed 18,000 feet. At the time of the last survey, in 1992, approximately 65% of rural customers served by an RUS financed provider were within 18,000 feet of a central office or carrier site, and theoretically could be provided with DSL service. That number is undoubtedly higher today, although the precise number will not be known until the next loop survey.

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71. Of the 551 cities in Appendix B, 39 could not be associated with entries in the Census Gazetteer and are not included in the chart.

72. There are well over 1,000 independent telephone companies providing service. Many of these companies did not have publicly available data. Even if they had, collection of these data would have been extremely time and resource intensive.

73. *See supra* note 35.

74. Salvatore Salamone, *DSL Heads to Smaller Cities – Start-Up New Edge Networks Aims to Ease Telecommuting Challenges*, Internet Week, Nov. 29, 1999.

75. News Release, *Northwest Telephone and Electric Lightwave Bring High-Tech Telecom to Rural Areas*, Nov. 8, 1999.

76. *See* §905(d)(3) of Rural Electrification Act of 1936, 7 U.S.C. §935(d)(3).

Because of recent upgrades by small and rural providers, many rural customers may soon be able to receive DSL service. The National Exchange Carrier Association (NECA) recently reported in its Access Market Survey that 14% of the respondents now provide DSL service.[77] More than 700 (68%) of the 1,000 small, mostly rural companies that participate in NECA's pooled interstate traffic sensitive access tariff responded to this survey.

The National Telephone Cooperative Association (NTCA) and the Organization for the Protection and Advancement of Small Telephone Companies (OPASTCO) also released a survey of 412 small, rural telephone companies, or approximately 40% of the small telephone companies in the United States.[78] According to NTCA, 29% of the 412 respondents are planning to offer (as opposed to providing) DSL service in at least part of their service areas.[79]

Nevertheless, the independents have yet to deploy DSL in their rural areas at the same rate as the RBOCs in their metropolitan areas, and their deployment is also dependent on density. According to engineers serving the independent carriers, the likelihood of offering advanced services in rural service areas is highest in the Southeast and Northeast, lower in the Midwest, and lowest in the Southwest. This roughly corresponds to the number of customers per route-mile (density) of plant in those areas. Low density equates to long loops. When loops are long, they are frequently loaded, which prevents DSL operation.

Another factor in the lower rate of independents' deployment is the fact that equipment has not been readily available for small carriers. Manufacturers have addressed the large lucrative markets by building equipment for the multi-thousand line offices found in urban areas. Rural areas, on the other hand, require small line counts and rugged equipment that frequently must function in a cabinet where there is no heating or cooling. With the recent adoption of the G.lite, standard (discussed below), which removed the uncertainty of competing but incompatible systems, it is expected that equipment suitable for rural installations will become more readily available.

Summary of Rates of Deployment in Rural Compared to Non-Rural Areas

Cable modem and DSL are the two broadband technologies that are now being rapidly deployed, permitting a comparison between rural and non-rural areas. The deployment of both technologies declines with population density. As a result, cable modem and DSL services, although increasingly available in rural towns, are still far more available in larger metropolitan areas.

77. National Exchange Carrier Association, *Keeping America Connected: The Broadband Challenge, Access Market Survey of NECA's Traffic Sensitive Pool Members*, December 1999. (www.neca.org/ams.htm) According to a NECA spokesperson, approximately 90% of customers receiving service from NECA pool members can receive some type of service beyond voice grade access on existing lines using "off-the-shelf" technology. This would include services such as extended range ISDN (128 kilobits/second) which do not meet the FCC definition of broadband.

78. National Telephone Cooperative Association (NTCA), *Internet/Broadband Availability Survey - Report*, September 15, 1999.

79. *Id.*

C. Capability of Enhancements and Feasibility of Alternatives for Rural Broadband

Issue 4. Capability of various technical enhancements to existing wireline and wireless networks to provide last mile advanced telecommunications capability in rural areas.

Both existing cable TV and telephone systems can be enhanced to provide broadband, although their capacities to serve rural areas vary. For cable, the system is typically upgraded to a hybrid fiber-coax (HFC) network. These upgrades involve building fiber to service nodes; replacing cables and connections that were either inadequate for digital data as originally installed, or that have deteriorated with time; replacing one-way amplifiers with two-way amplifiers; and placing new amplifiers at closer intervals than original amplifiers. The new amplifiers that meet these control requirements are more expensive than those required for television transmission. Systems must also be installed for monitoring and controlling signal levels within the cable system.

For rural towns, cable offers a viable "last mile" option as long as the cable operator is willing to make a significant investment to upgrade the plant. As explained above, a significant number of cable operators say that they will make that investment to serve rural towns. On the other hand, as noted, cable modem services do not generally reach out-of-town rural customers because the cable plant itself does not extend into those areas.

In contrast to the extensive physical upgrades that are usually required throughout a cable network to provide cable modem services, DSL can be provided to the majority of telephone customers by installing high-speed switches (called DSL Access Multiplexers, or DSLAMs) in local telephone company central office and subscriber carrier sites. As discussed earlier, telephone plant can support DSL if the customer does not live more than 18,000 feet from the DSLAM equipped point. As also mentioned above, the 1992 RUS loop survey shows that at least 65% of the rural plant in RUS-financed systems is DSL capable. The readiness of national plant is undoubtedly higher because it encompasses non-rural, therefore shorter, loops.[80]

As long as the plant is DSL-capable, DSL can offer a last mile solution in hard-to-serve rural areas. Rural carriers building new plant have stated that building DSL-capable loop plant is generally only 20%-35% more expensive than non-DSL capable plant. The development of G.lite has also made it easier to deploy DSL to rural areas. G.lite is a new DSL standard that generally limits customers to 1.5 Megabits/second downstream and 500 kilobits/ second upstream. It trades slightly reduced bandwidth (relative to higher rate types of DSL) for reliable operation on most existing telephone lines. Operating under this new standard, twisted pair can provide up to 1.5 megabits/second out to 14,000 feet on 26-gauge copper and 18,000 feet on 24 gauge cable. This range, coupled with the presence of subscriber carrier serving areas in the countryside, may make DSL more practical than cable modems for remote areas.

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80. Recent surveys demonstrate that approximately 80% of customers nationwide gain access to the Internet at rates of at least 28 kilobits/second. This level of performance strongly correlates with operation over loops shorter than 18,000 feet. *See* http://808hi.com/56k/_out (providing, *inter alia*, surveys of 3Com and Lucent users).